Cecil French

Silkworm Rearing as a pastime.

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SILKWORM REARING

AS A PASTIME

(WITH SIX ILLUSTRATIONS)

BY

Dr. CECIL FRENCH, Naturalist,

WASHINGTON, D. C., U. S. A.

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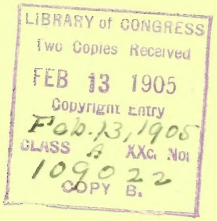

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Silkworm Rearing as a Pastime

By Dr. CECIL FRENCH, Naturalist,

WASHINGTON, D. C.

PREFACE

THIS little booklet has been written as a practical guide for the amateur Silkworm Culturist, to afford an elementary course of instruction in the successful pursuit of a most delightful and fascinating pastime. It is not intended for the professional sericulturist and no attempt has been made to treat the subject from a scientific or technical standpoint. Indeed, were I to attempt the latter I should feel I were treading upon hallowed ground, for classical instruction in the industry is a matter of history, referred to by Aristotle and having its being at least four thousand five hundred years ago in China, the country in which the domestication of the insect is generally believed to have had its inception. What I have written here is the record of my own experience, a description of the methods by which a great amount of amusement can be had. To the professional sericulturist these methods will be open to criticism, but the pursuit of a pastime should have no pecuniary benefit in view, and if I do not advocate the observance of hard and fast rules and attention to minor details, it is because I wish to avoid making the pastime

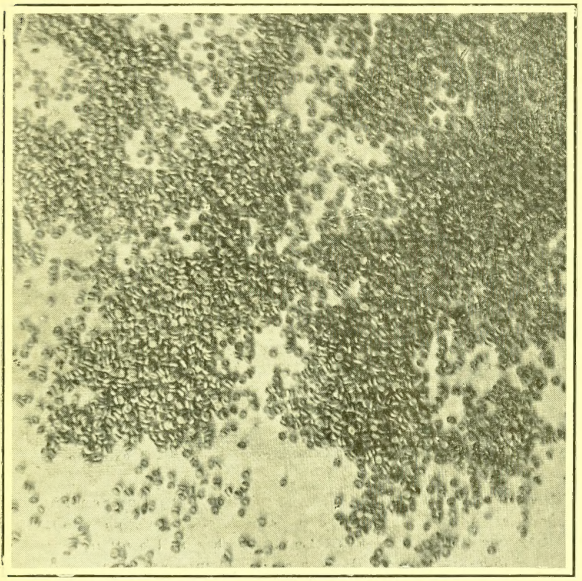
irksome. At the same time I should remind my rea that whilst the instruction here imparted applies to rearing of the domesticated silkworm on a small scale the home, there are many species of silkworms, differing from each other in certain of their habits, and the metho of rearing advocated in the following pages is a modification of the methods practised on a large scale by the professional sericulturists.

Aside from the ample reward that will be found in knowledge gained of the marvelous workings of nature and the absorbing interest that will be aroused, a quantity of beautiful silk can be produced which may be put to such use as bookmarkers. I remember as a boy how I used to steal from my bed on the tiptoe of expectancy in the small hours of the morning to watch for the first appearance of my little brood of spinners, and later with what pleasure I presented to my mother and sisters the skeins of beautiful silk. There was no lagging of interest, for the lifetime of the little busybodies was far too brief.

In houses with limited room, the raising of more than a hundred worms will prove impracticable and should not be attempted, and even this number will require an astonishing amount of space.

CARE OF THE EGGS.

The first essential is proper care of the eggs. These are received either grouped in clusters adherent to paper or other material or loose like seeds in a packet. They are of a dull grey or slightly greenish tint, though when first laid are yellow. Life within them remains dormant from autumn of the preceding



HE EGGS—The eggs, when spread out to hatch should not be bunched as much as they appear in this picture but should be more scattered.

season until about February or March according to the climate. Under normal conditions when the temperature rises above 50° F. development of the embryo commences and it will be readily understood that some provision must be made to protect the delicate

embryo from sudden climatic changes and particularly to guard against premature hatching in the artificially heated rooms of the average house. Fortunately, most households maintain an ideal place, namely, a refrigerator. The eggs should be placed in a small tin box in which there are holes punctured for ventilation, and deposited in the refrigerator until the time for hatching arrives.

HATCHING THE EGGS.

With the advent of warm weather and the appearance of vegetation, preparations must be made for the hatching of the brood. There is no better way of determining the right time than by watching for the budding of the mulberry trees. If there are no mulberry trees at hand to observe, the latter part of April may be chosen in the milder climates and the early part of May in more northerly regions; but, in any case, the supply of food must be secured.

In the large establishments proper temperature is considered a very important matter, for upon it will depend the rapidity of incubation and the regularity and percentage of hatchings. Incubators are used just as they are in chicken hatcheries, and a temperature of round about 70° F. is maintained. But for parlor culture the ordinary living room temperature will suffice, though, if the nights threaten to bring about any great variation, it is better to place the eggs where they will keep warm.

Humidity is also considered an important matter just as it is in the hatching of chickens. However, I never pinned much faith on this, but no harm is done in sprinkling a little warm water in the vicinity of the eggs, or better still, in keeping a shallow dish of water near them.

The eggs are set out to hatch in the light but on no account in the direct rays of the sun. If the eggs are separate like seeds they should be spread out in a thin layer upon sheets of blotting-paper. In about seven or eight days and sometimes even earlier (the length of time depending on temperature) the first hatchings take place. The period of incubation, when hatchings are undertaken out of season, as for instance, in the winter months, is somewhat longer, averaging three weeks. The imminence of hatching can be determined by the whitening of the eggs. Without the aid of an incubator the hatchings are always more or less irregular and extend over a week. The first worms to put in an appearance are the

strongest and all worms emerging after the fourth or fifth day should be destroyed as they are generally weakly and not worth the trouble of rearing. In an irregular hatching, which is unavoidable without the aid of an incubator, two colonies should be formed, the earlier and better developed worms being segregated into one, the more tardy ones into the other. The hatchings take place mostly in the early morning hours, between 4 and 9 o'clock, so that he who would observe the process must be up betimes.

FOOD SUPPLY

If there is any one distinguishing feature of the silkworm's life it is the remarkable capacity of this little creature to eat. The greediest hog cannot surpass it in voracity. In the active phases of its development its prime object seems to be to eat both day and night. But we do not begrudge it this capacious appetite when we remember what it portends—the storing up of the energy and material necessary for the wonderful work of silk production. In fact, the more food we can encourage the little cr ature to crowd into its alimentary canal during its brief lifetime, the greater may we expect the yield of silk.

As I have already pointed out, the food supply must be secured in anticipation of the hatchings. The natural food of the silkworm is the mulberry leaf. There are many varieties of mulberry trees, but the best for the purpose is the White Mulberry which is to be found in many parts of the United States. However, mulberry leaf is not absolutely necessary for the nourishment of the silkworm, for I have raised them on lettuce leaf, which they will eat with relish, when, for some reason or other mulberry leaf was not obtainable. They can even be kept alive for a time on the leaf of the dandylion and one or two other plants, amongst them the Osage orange, but of this latter the young and succulent leaves should not be fed But none of these substitutes enables the worm to thrive and produce the quality or quantity of silk that it does from the mulberry. Therefore, every effort should be made to obtain a supply of mulberry leaf. If the culturist resides in the city he must solicit the aid of some friend in the country or make arrangements with some nursery. Mulberry leaves can be easily sent from one point to another by mail. A fresh supply should be obtained at least once a week. The leaves can be kept fresh a few days by putting them in a jar and covering the latter with a damp

cloth. But the leaves must not be allowed to get wet or heated as such conditions are highly conducive to disease. The blossoms and berries must be discarded and only healthy looking leaves provided. If lettuce is used it must be thoroughly dried and cut up in small pieces.

How often should the worm be fed? In China feeding operations are actually undertaken every half hour. In this country and in Europe it is customary in the large establishments to adopt regular hours for feeding, beginning very early in the morning and ending late at night. The food (leaf) is also cut up into small pieces. But for parlor culture such niceties are by no means imperative. It is possible to provide at one feeding sufficient leaf to carry each individual through the succeeding twenty-four hours. In fact, in my boyhood days this scant attention was frequently all that my broods received. A safe rule is to keep pace with the creature's appetite, remembering that it is in the early hours of the morning when its appetite is keenest, that it is most in need of a bountiful supply of food. I have never found mincing or chopping up of the leaves necessary, though this little attention is perhaps helpful to the tender worm in the first stage of its existence, because its sustenance is obtained from the juice of the leaf at first.

THE NURSERY

In what kind of rearing place should the worms be kept? The lid of any old cardboard box answers the purpose admirably and as the worm increases in size the box itself should be used. The top is left open and there need be no fear of any of the worms escaping or wandering far as long as there is a supply of food within. But let the food supply once diminish and out will crawl the creature in search of a more congenial environment. Several of these extemporized trays should be kept at hand for not only will they be needed to afford a frequent transfer to clean quarters but the rearing space will have to be increased as the germs enlarge. Any odd shelf or window sill out of the sun's rays will suffice as a depository for the trays. A room should be selected which is not subject to draughts or variations of temperature but at the same time admits of free ventilation. Living room temperature is most suitable.

It need hardly be mentioned that throughout the life of the worm its surroundings must be kept as clean as possible. If excrement is allowed to accumulate in the bottom of the tray unhy-

gienic conditions are created which are a fertile source of disease. Frequent changes to clean quarters are necessary.

To save time and labor in effecting the daily transfer of hundreds of worms, a device is made use of in the form of a net having a mesh of a size suitable to the age of the worm and stretched upon a wooden frame. At night time the last meal is distributed over the net and the latter is extended over the worms. During the night the ever-hungry worms, scenting the fresh leaf, desert their stale feeding ground and find their way up through the meshes. The entire colony is then lifted wholesale and deposited in clean quarters. But on a small scale such facilities can be dispensed with. The very small worms may be picked up and moved with a (genuine) camel's hair brush, whilst the larger worms may be transferred with the fingers. If gentleness is observed there need be no fear of injuring the worms. The first change of quarters should be made about the fourth day.

THE PHASES OF LIFE

When certain stages of development are reached the silkworm undergoes a process known as "molting," when the entire skin is shed. Four of these molts take place at intervals of a few days, during which there is a suspension of activity, thus dividing the active life of the animal up into five distinct phases.

First Phase—The hatchings having taken place the newly born youngsters are picked up with a camel's-hair brush and placed in the tray in which there has previously been evenly distributed a layer of finely cut up leaf. An ample supply of food being furnished, development proceeds apace until about the fifth day, when the worm is observed to lose its appetite and become sluggish. This inaction usually creates disappointment or apprehension in the mind of the novice if he has not previously fortified himself with the knowledge of what is impending. In a few hours the worm ceases to eat altogether and appears to lose flesh, its skin becomes shiny and it attaches itself to the stem of a leaf or other convenient point and remains motionless with its head raised. Less food is now required for the remainder and none at all if every worm in the colony is molting at the same time, but as this rarely happens, food must be provided for those that are in an active state. From twenty-four to forty-eight hours are spent in ridding itself of its old skin which it does by crawling out forwards. If touched during this period it shakes the forepart of its body.

Second Phase—On coming out of the molt, the worm, which has now assumed a greyish color, looks around for food. At this stage increased space must be provided and it is better to further divide up the worms, putting all the forward ones in one tray and the backward ones in another. About the fourth day they should all be transferred again to clean quarters. The second phase lasts about five or six days when the worms again enter upon a molt.

Third Phase—This is very similar to the first two and treatment should be along the same lines but with an increased supply of food, for the worms now grow very perceptibly. In color they become much paler. About the fifth day change of quarters must be made and on the sixth or seventh we look for the third molt. Strangely enough, this molt and the fourth phase of the creature's life are the most critical, when diseases are prone to develop. During the change it is important to keep the surroundings as dry a d clean as possible.

Fourth Phase—In this phase the worm eats more than ever and large quantities of leaf must be provided. Change to clean quarters must also be made more often, and as often as the change is made the space should be increased. Particular care must also be bestowed on the selection of the leaf, avoiding any that is damp or moldy. The fourth and last molt takes place about the sixth day.

Fifth Phase—This is the most interesting of all when returns may be looked for. The worm now eats a prodigious quantity of food and grows astonishingly, and the object should be to encourage it to stuff itself to the utmost limit. Fifty worms during this phase will eat from three to five ounces of leaves daily. Change to clean quarters must now be made daily, and the space still further increased. In about six or seven days, sometimes longer, the appetite begins to diminish, the worm appears to shrink, and it assumes a transparent color. In two or three days feeding is altogether suspended and the worm acts in an uneasy manner, crawls aimlessly up and about and raises and moves its head to and fro as if seeking something. In reality it is looking for a convenient place to spin. A corner of the box is generally selected though it will sometimes wander beyond the confines of the latter, always going upwards. Soon it begins to throw around it a loose "cobweb" of silk. At this point it must be carefully transferred to a spinning place. The best depository for this purpose is a paper cornucopia about five or six inches in length.

Each worm is provided with its own individual refuge and the cornucopias may be pinned to the wall in a row. As a rule the worm will gratefully remain where it is placed and at once proceed to carry out its task. If it does not remain within its refuge it is a sign that it is not yet ready to spin and it should be returned to its feeding quarters.

A Colony of well-grown Worms hard at work devouring mulberry leaves. The worms are too crowded in this picture. More space should be alloted than is here shown.

If the worm is watched in the process of spinning it will be observed ceaselessly moving its head to and fro in the act of running the thread of silk backwards and forwards in an irregular manner. During the first six hours an outer loose web-like structure is

thrown around itself. In the center of this it then proceeds to spin around itself the compact cocoon proper. The process lasts some three days and during this time it moves its head to and fro some 250,000 times and pays out a half mile or more of delicate golden cable. An idea of the extreme delicacy of this fiber may be

Paper Cornucopia containing a cocoon surrounded by its floss. The cornucopia is always intact; a hole has been cut in it in this instance in order to afford a glimpse at the cocoon.

gathered from the fact that it takes from sixty to one hundred single fibers to make the thickness of ordinary sewing silk. The silk which the creature elaborates is the product of a semi-fluid glandular secretion which hardens on exposure to the atmosphere. It comes from the worm in two microscopic strands which adhere firmly together.

Within the cocoon in the course of the next seven or eight days the worm or larva undergoes its transformation into the chrysalis state, and during this period passes through a sort of fifth molt. It sheds its skin and remains motionless. In from two to three weeks from the time spinning is commenced, if it is left undisturbed, it will have developed into a moth which will at once begin to eat its way through the cocoon at the expense of the latter. This brings us to the consideration of what to the amateur is a very important matter, viz:

DISPOSITION OF THE COCOON

The technical works all teach that certain of the cocoons should be set aside for propagating purposes, the finest cocoons from worms which have been the earliest to spin being selected and carefully laid away and the moths allowed to eat their way out in a natural manner. This means, of course, that the silk from these particular cocoons cannot be utilized, for in the act of its emergence the worm necessarily destroys the continuity of the thread. The balance of the cocoons forming the main harvest are then subjected to the fumes of bisulphide of carbon or to steam for the purpose of killing the chrysalides. This is done in order to prevent the moth from eating its way out and destroying the silk before the latter can be reeled. It is a necessary step where a large number of cocoons is to be dealt with and the silk cannot be reeled within the limited time prior to the moth's appearance.

Thus, it will be seen that the professional methods entail the loss of part of the silk harvest on the one hand and a number of breeding moths on the other. Now, to the amateur this is a matter of no small concern. In any case his harvest of cocoons and moths wherewith to propogate his stock is limited and he wants "to get all that is coming to him." It takes the reeling of at least eight or ten cocoons to make a skein of raw silk worth having.

As a matter of fact the professional method of treatment at this stage would be, for a limited number of cocoons, highly extravagant; it would virtually be throwing away part of what it has taken so much pains to produce. It is possible to utilize the silk from every cocoon and at the same time save every moth for propagating purposes, but to accomplish this it is necessary to reel the silk soon after spinning has been completed and to carefully harbor the chrysalis in suitable surroundings where it may continue to undergo transformation into its final phase, that of the moth.

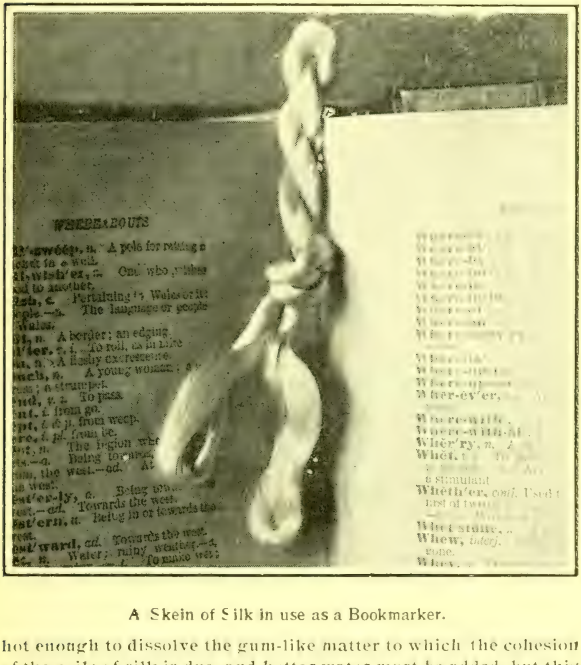
L. of C.

I have already noted that it takes some seven or eight days for the worm to complete the cocoon. It can easily be ascertained when this stage has been reached by shaking the cornucopia containing the cocoon. If there is a rattling within the time for reel-

Reeling the silk by means of a strip of cardboard.

ing is ripe. The cocoon is thereupon removed from the cornucopia and the outer cobweb-like floss pulled off. It is next placed in a bowl or tumbler of moderately hot water such as can comfortably be borne by the hand After lying in the water a short time it is taken out and whisked over with a small stiff brush (a nail brush

will answer the purpose) until the end of the thread is caught up. The end of the thread can also be secured by picking with the fingers at the surface of the cocoon. The cocoon is then dropped back in the water and the reeling proceeds. If during the reeling the thread does not come away freely, but catches and lifts the cocoon out of the water, it is an indication that the water is not



A Skein of Silk in use as a Bookmarker.

hot enough to dissolve the gum-like matter to which the cohesion of the coils of silk is due, and hotter water must be added, but this should be done cautiously and the water not made too hot, or there is danger of the chrysalis being killed. A simple way to keep the cocoon from coming out of the bowl is to lay a heavy piece of card-

board over the top of the latter, allowing only a small open space for the thread to pass through. The jar sustained by the cocoon on coming in contact with the cardboard is sufficient to disengage the thread and cause the cocoon to fall back into the water. The reeling is continued until practically no thread remains and we come upon a flimsy silken skin enveloping the chrysalis. Of course, the thread will sometimes break, in which case the broken end is caught up and the winding continued.

For reeling the silk many devices have been invented and with a little skill and a few tools an inexpensive winder can be constructed. But for limited use such adjunct can be dispensed with and the silk reeled off on a strip of cardboard about five inches in width and eight in length as shown in the accompanying illustration. When five or six cocoons have been reeled off to form one skein the latter is removed from the cardboard. To convert it into a bookmarker it only remains to tie it in a knot in the center.

TREATMENT OF THE CHRYSALIS

It must be remembered that by disrobing the chrysalis of its protective coating of silk we subject it to an unnatural condition and the very first thing we need to do is to afford it an artificial covering. This difficulty is easily overcome by the employment of bran. The ever useful cardboard box is again brought into requisition and filled with the bran in the depths of which the chrysalis is buried after removing it from the aforementioned flimsy skin. This chrysalis is golden colored at first but soon turns to a chestnut brown. The bran and its contents must be deposited in a warm place.

When the development of the chrysalis into the moth is complete the external shell bursts asunder and out crawls the moth. This takes place in the early hours of the morning. As soon as possible the moths must be transferred to another cardboard box on the bottom of which a sheet of stout paper has been laid. The lid may be left off as the moths cannot fly in the air and they do not need any nourishment at any time of their brief existence.

Shortly after emerging the moth excretes a fluid matter and then union of the sexes takes place. This lasts several hours when the moths separate and the female soon starts in to lay her eggs on the paper. The female can always be distinguished from the male by her larger abdomen and the male from the female by

constant fluttering of his wings. About three or four hundred eggs are laid by each female in the course of three days, the majority being deposited at the start. Then, in a few hours' time the strenuous life of the little creature is brought to a close by its death.

The Moths shortly after emergence from the Chrysalis.

Finally, the strips of paper to which the eggs are adherent are gathered up and stored away where there is no artificial warmth until the following season.

DISEASES

A description of this sort would not be complete without a brief reference to the diseases from which silkworms suffer. One

very deadly scourge termed "plague" has in the past been the cause of immeasurable financial loss in the sericultural countries of both Europe and Asia, and in one country at least, namely, France, has been the subject of governmental investigation. Pasteur has written a book on the diseases of the silkworm. I will not enter into this subject further than to state that they are mostly of an infectious or contagious nature and that prevention is better than cure The hope of prevention lies in keeping the worms in clean healthy surroundings, in providing nothing but the best of food, and in promptly removing healthy worms from the neighborhood of any which may be observed to be diseased or dead.

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